Trends and environmental implications of X_2 in Northern San Francisco Bay, 1988-2012

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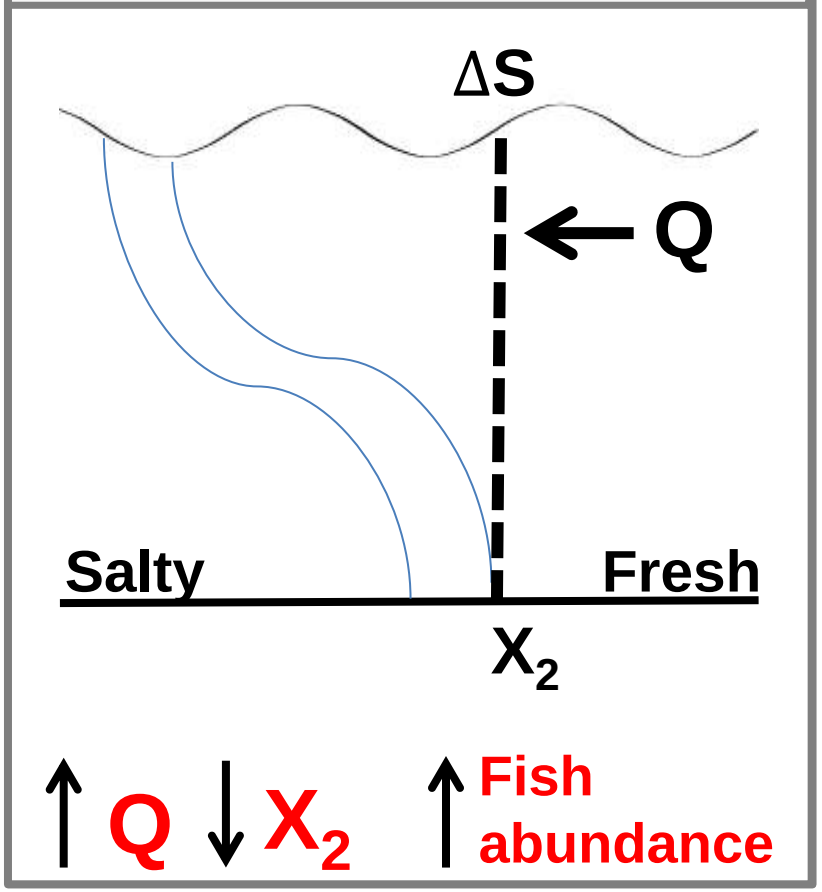
Background

What is X_2?

Distance where bottom salinity is 2 psu.

Why should we care?



Habitat indicator & links to turbidity.

(Jassby et al., 1995)

Goal

Provide an updated analysis of how X_2 has evolved over the past 20+ years with in-situ measurements.

- USGS water quality transects (**monthly** CTD profiles, **1988 - 2014**)
- USBR/CDWR salinity stations (**hourly** top & bottom, **1999 - 2012**)
- DAYFLOW estimates freshwater outflow at Chipps Island (**daily**, **1988 - 2013**)

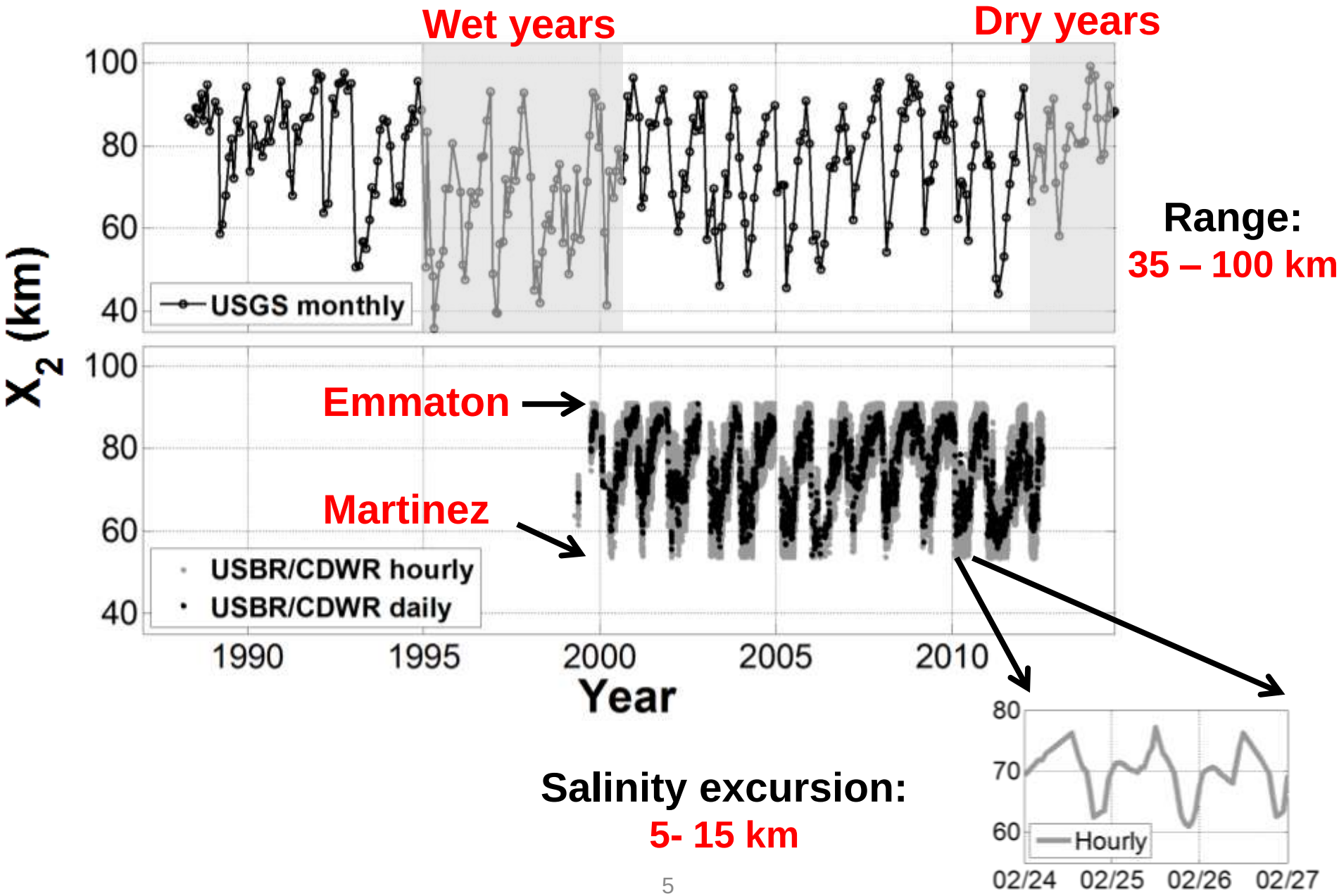
(CDEC, 2013; USGS, 2014)

Overview

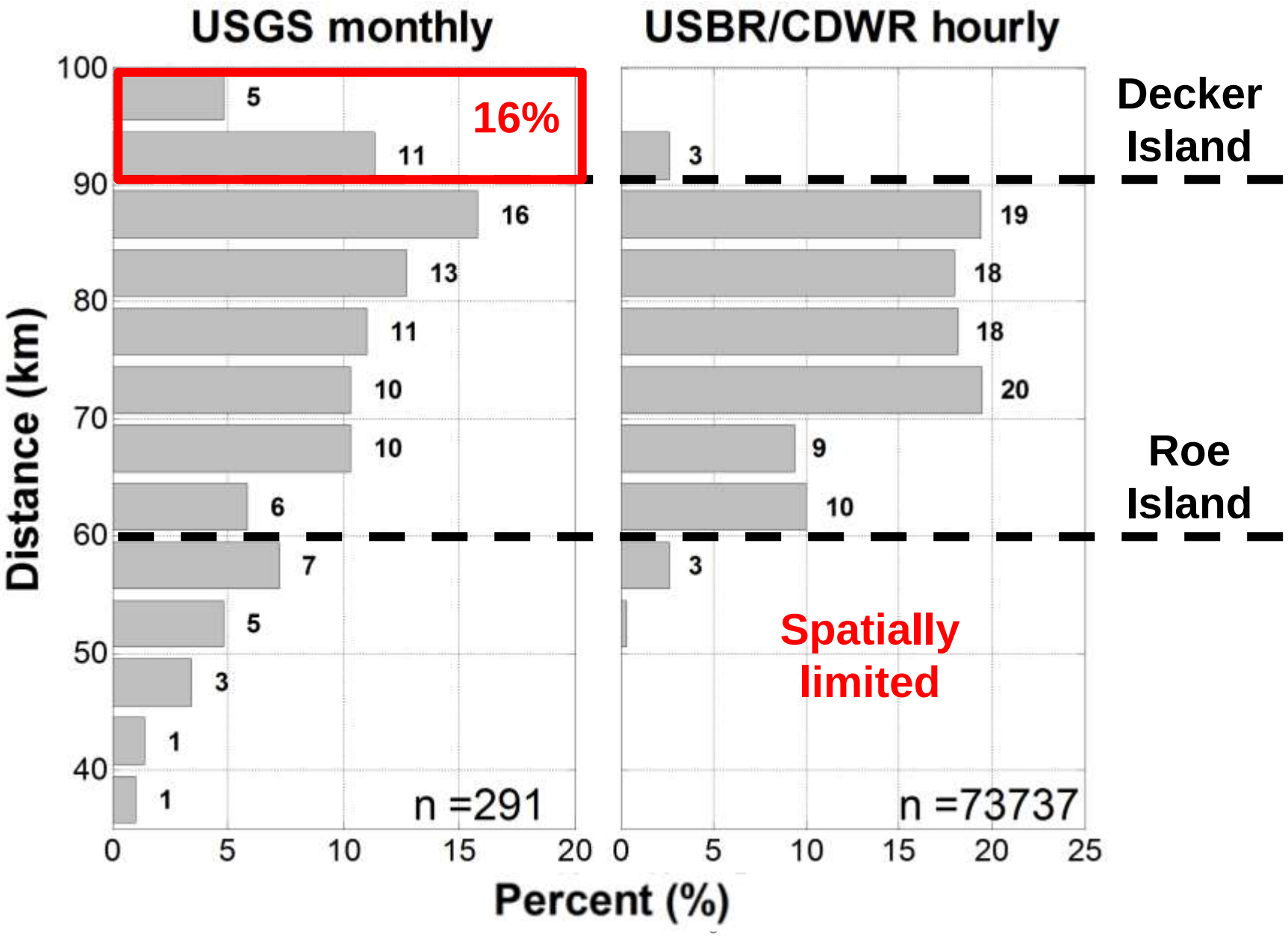
1. What is the current relationship between X_2 and flow?

2. What are the implications of changing X_2 on the salinity field, total suspended solids, and chlorophyll *a* concentrations?

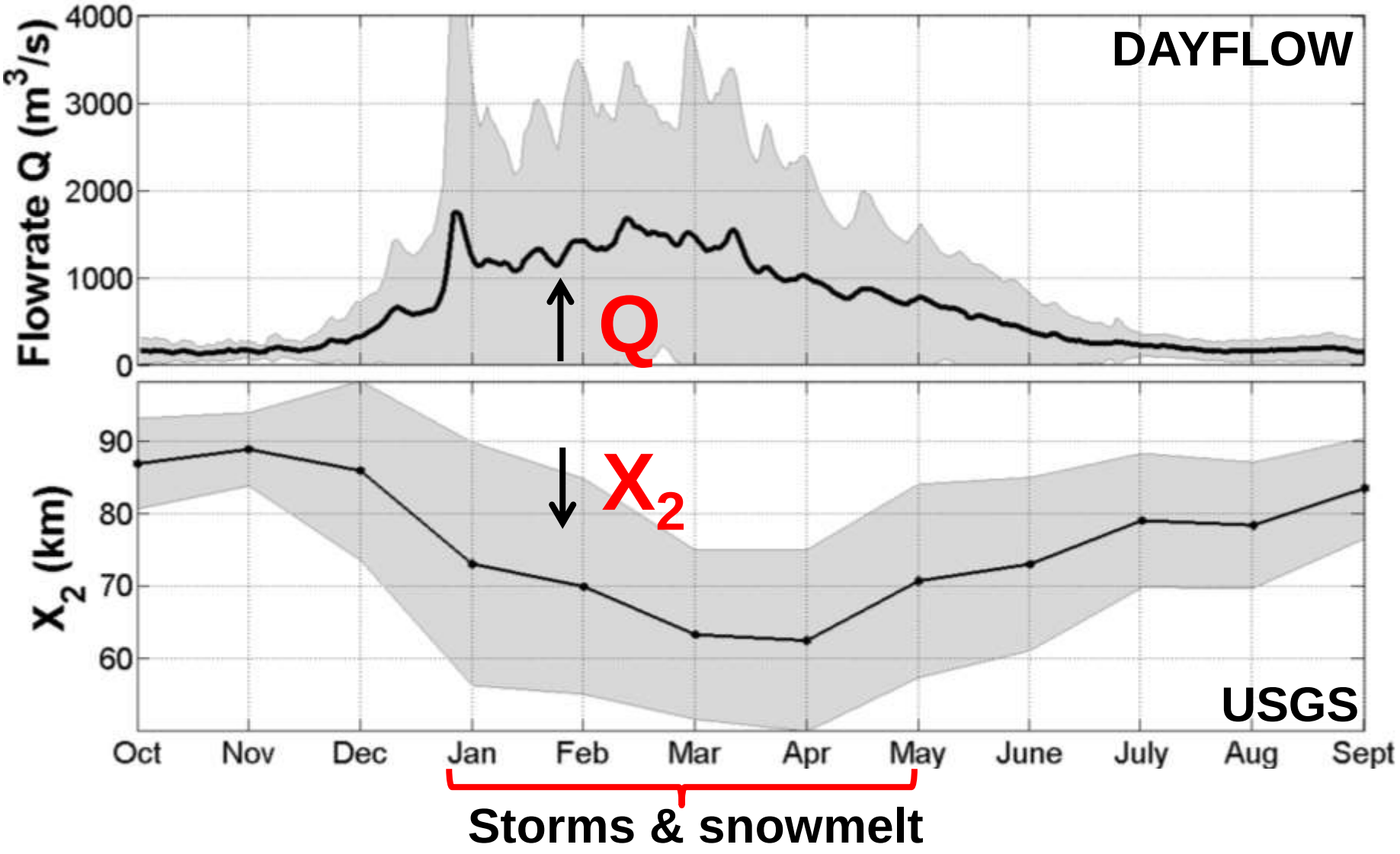
Global look at X_2



Where is X_2?


USGS monthly
USBR/CDWR hourly
Distance (km)
Percent (%)
16%
n =291
n =73737
Decker Island
Roe Island
Spatially limited
100
90
80
70
60
50
40
0
5
10
15
20
25
5
11
16
13
11
10
10
6
7
5
3
1
1
3
19
18
18
20
9
10
3

How does X_2 look in time?

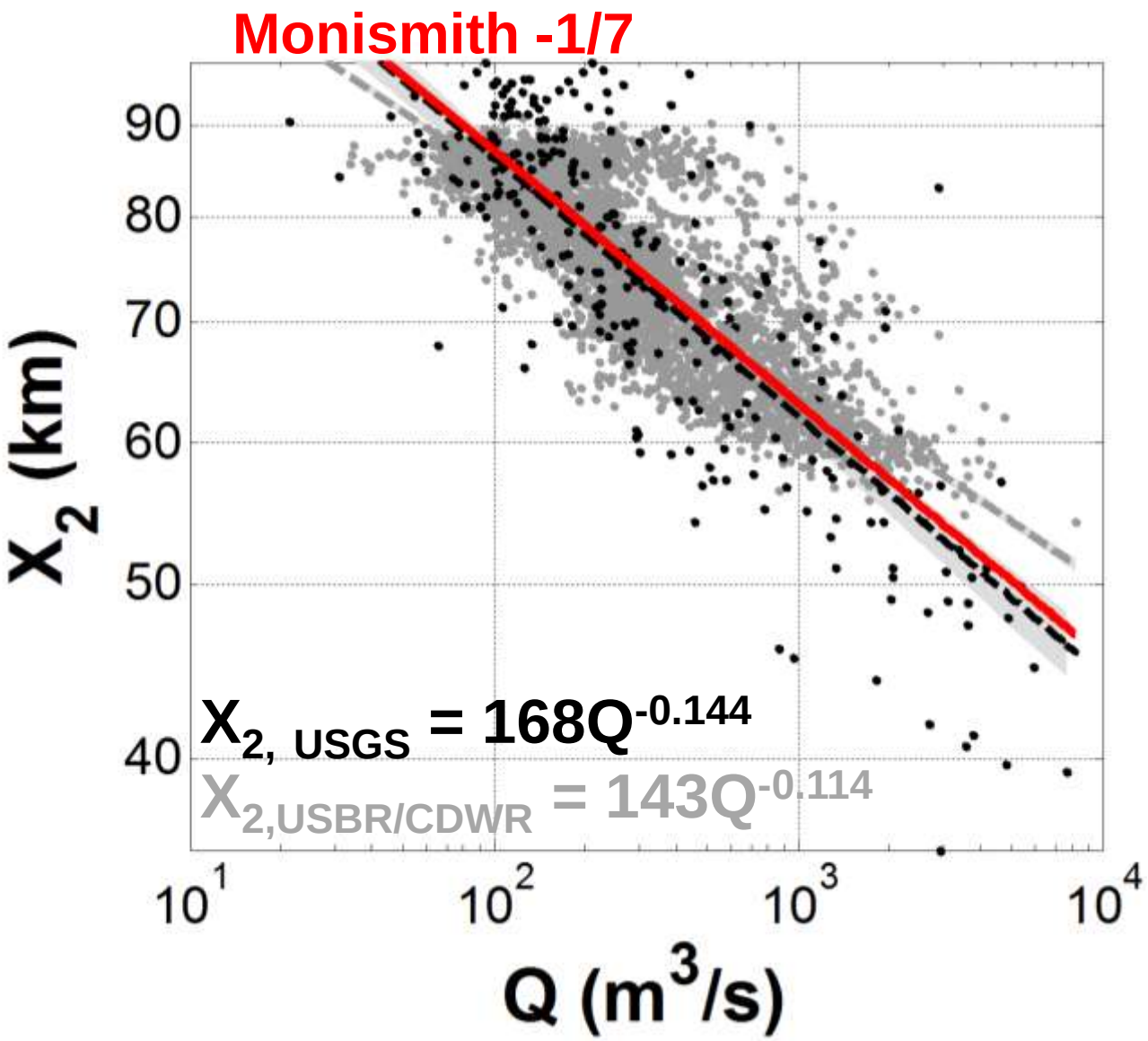


What do we know?

Type	Relationship	Source
Theory	$X_2 \propto Q^{-1/3}$	Hansen & Rattray (1965)
Unsteady (field)	$X_2(t) = 8 + 0.945X_2(t-1) - 1.5 \log(Q(t))$	Jassby et al. (1995)
Steady (field)	$X_2 = 167Q^{-0.141}$	Monismith et al. (2002)
Steady (model)	$X_2 = 210Q^{-0.182}$	Gross et al. (2010)
Direct computation	Compute surface salinity & assume $\Delta S = 0.64$ psu	USBR/CDWR
Unsteady	Based on Jassby's formulation	DAYFLOW

NSFB: -1/7 to -1/5

X_2 vs. flow



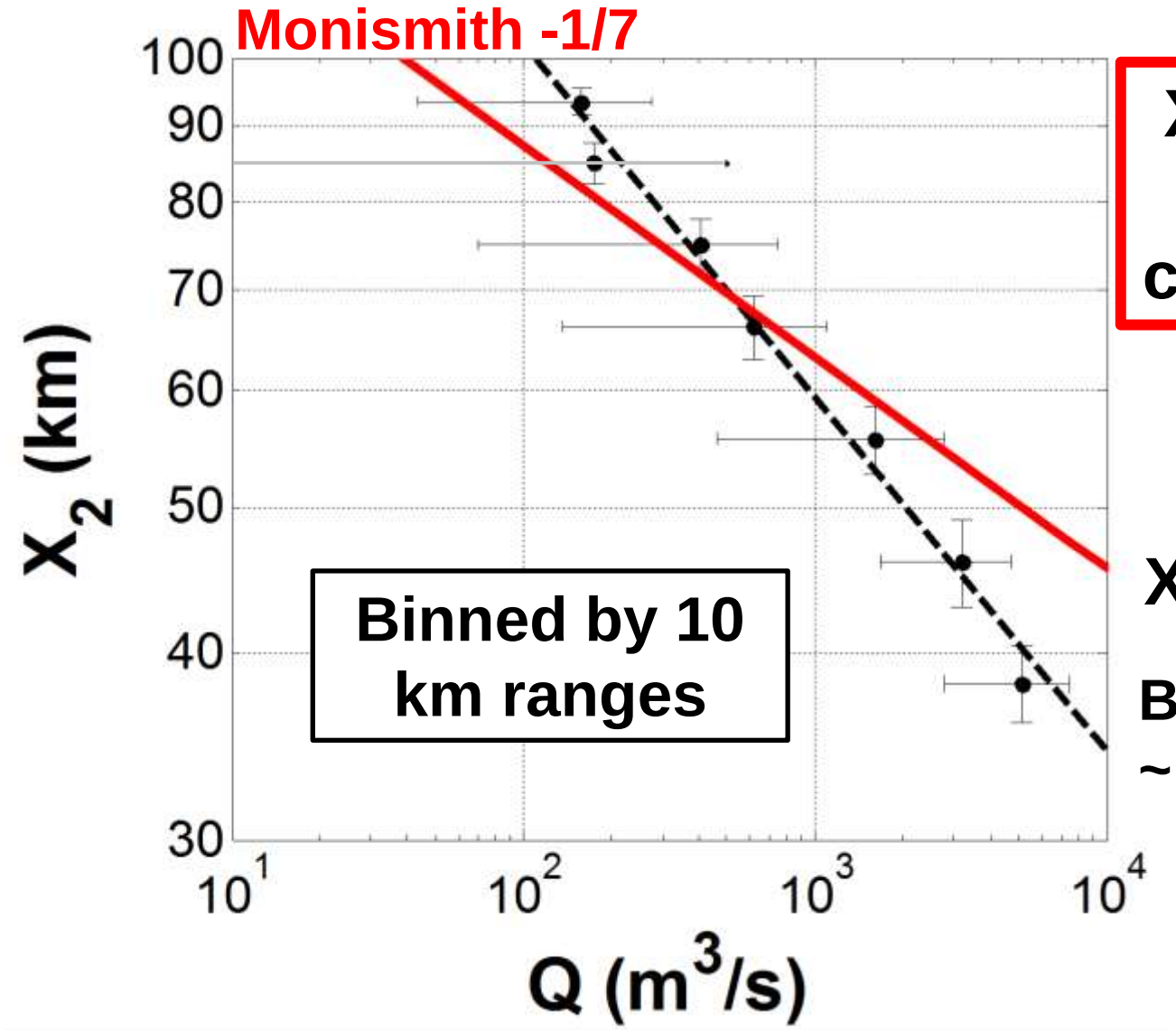
Considerations:

USGS:
X_2 **instantaneous vs Q daily**

USBR/CDWR:
spatially limited

DAYFLOW:
Uncertainty unknown

Battle of the exponents



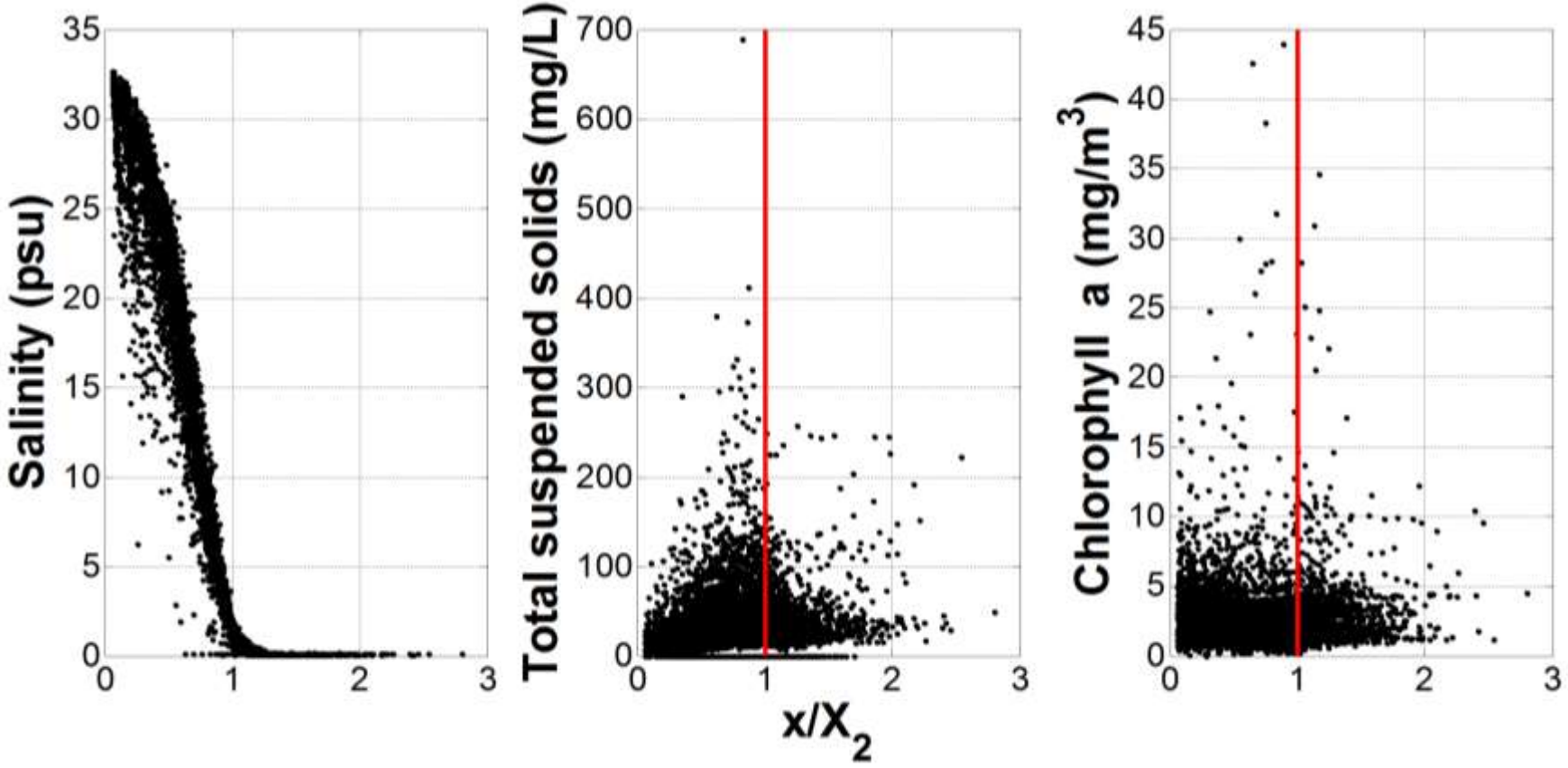
X_2 may be more sensitive to changes in flow?

$X_{2,\ USGS} = 303Q^{-0.237}$

Binned USGS ~ -1/4

X_2 & environmental variables

USGS depth-averaged quantities

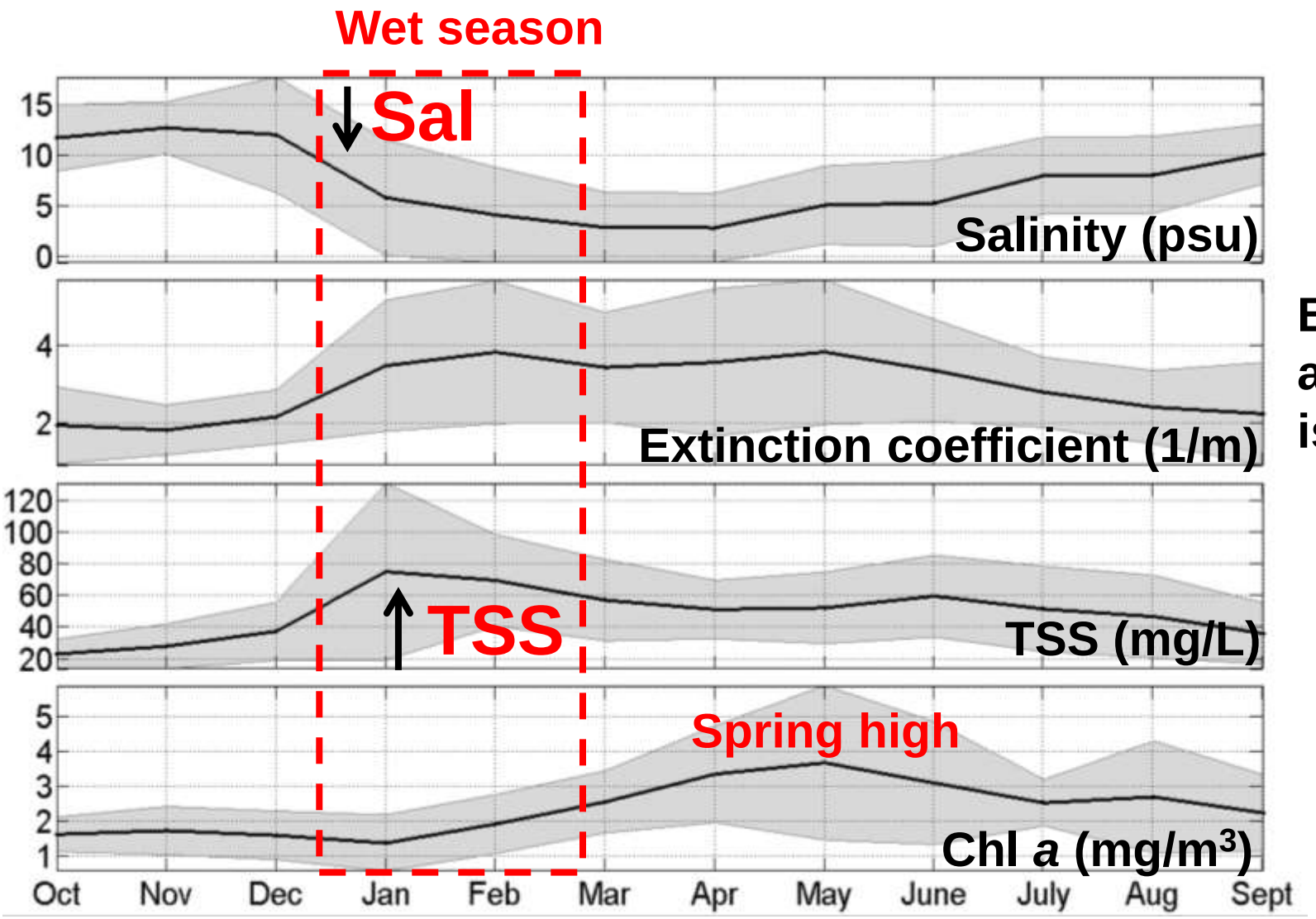


Salinity field is self-consistent

Peak turbidity centered near X_2

Chl *a* more scattered

Closer look at Roe Island (USGS S6)

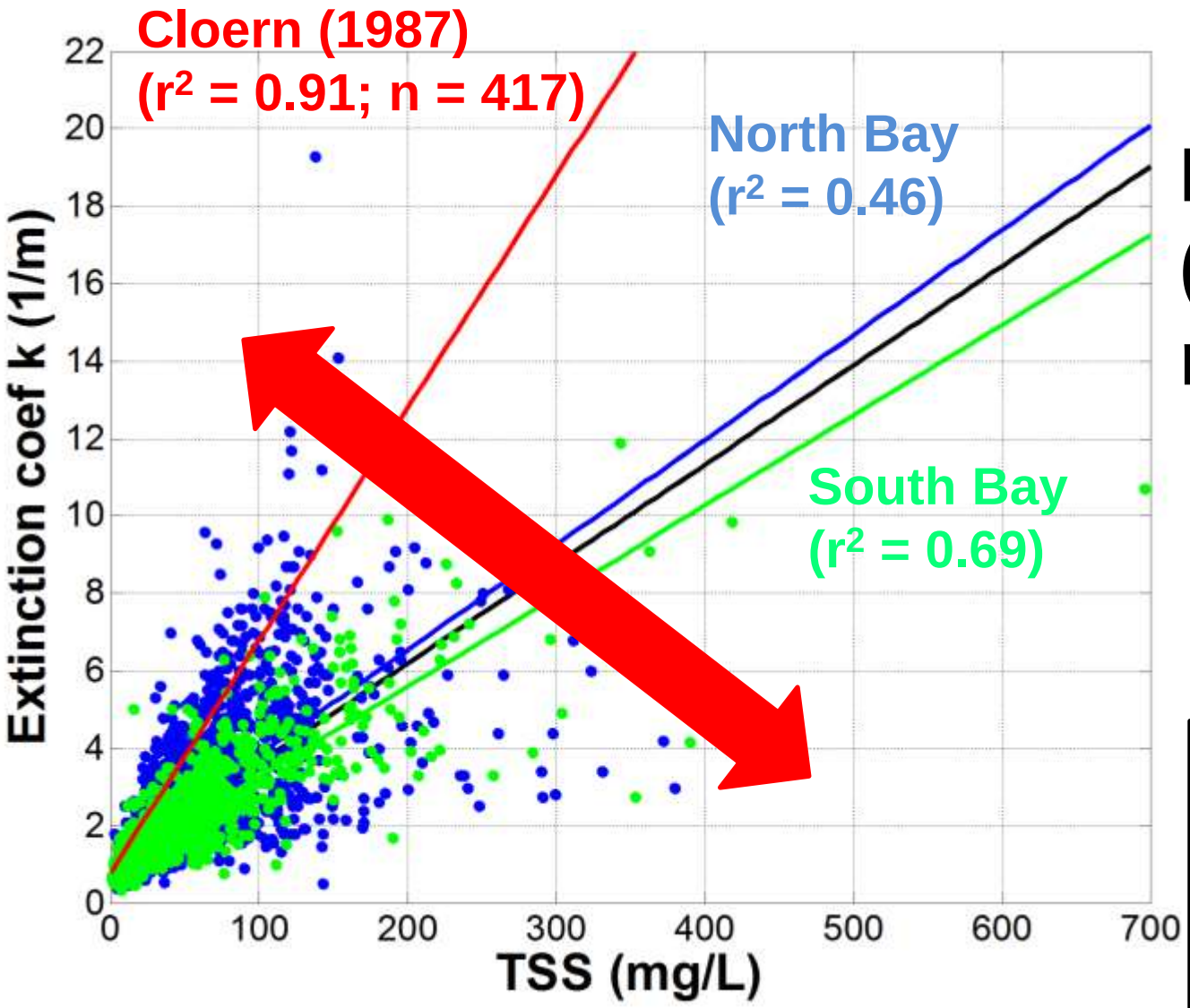


But light attenuation is still high?

↓ TSS

↑ Chl *a*

TSS vs. extinction coefficient

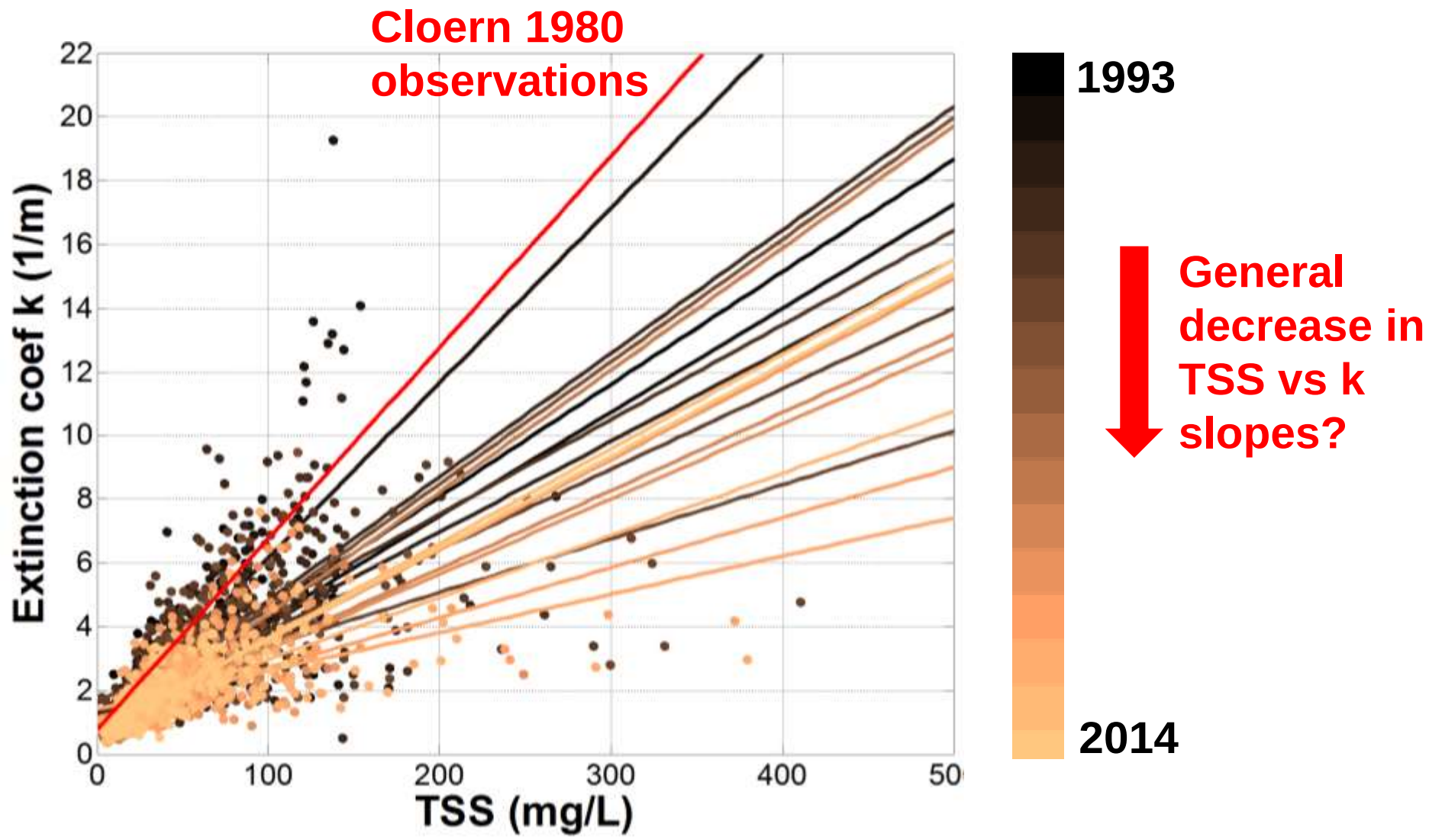


Full bay
(r^2 = 0.52;
n = 4883)

↑k

↓ light penetration

NSFB: Changes in time



Summary & moving forward

X_2 vs. Q

- Increase spatial & temporal coverage of bottom salinity
- Better estimates of Q & its uncertainty

Links to TSS & Chl *a* ?

- Stronger response between X_2 & TSS
- Relationship between k, TSS, and Chl *a* needs further exploration
- USBR/CDWR stations update

For more X_2 talks today…

11:40 AM (Rm 306)

A Reevaluation of the Relationships Between X_2, the Low Salinity Zone, and Fish Habitat Utilization by Michael MacWilliams

1:55 PM (Rm 314)

Salinity and Flow Variability in Suisun Bay during FLaSH by Liv Herdman